THE WEATHER AND CIRCULATION OF JULY 1967

Unusually Cool East of the Divide

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1. MEAN CIRCULATION

From June to July progression of long wave features at middle and high latitudes was observed throughout the Western Hemisphere. This progression can be viewed within the context of the zonal wind profile at 700-mb. (fig. 1). The profile displays stronger than normal westerlies north of 47.5°N. latitude and weaker than normal westerlies south of that latitude. Thus, progression appears related to decreasing upper level heights over the Arctic from June to July as a blocking ridge retrograded to north-central Asia (figs. 2, 3).

Retrogression of this blocking ridge has been a long term phenomenon which began in mid-April in the Aleutians. As the block moved from its June position over northeastern Asia, the Asiatic coastal trough, which had been strong only in the south during June [1], opened to the north and progressed during July. The west Pacific ridge, which also had been suppressed by high latitude blocking during June, progressed and amplified strongly during July. From this feature eastward to Europe, progression of nearly all long wave features in the westerlies can be noted from June to July.

In the vicinity of North America this resulted in essentially a reversal of June's long wave distribution with troughs replacing ridges along the west coast and in eastern North America and ridge replacing trough in the Far West. The fast westerlies over the Atlantic during June [1] diminished markedly during July as an amplifying ridge moved into the western Atlantic. East of this ridge a strong trough moved into the eastern Atlantic while June's ridge near the British Isles moved over the Continent. Over Asia, marked deepening took place at middle latitudes to the south of the retrograding blocking ridge.

2. TEMPERATURE

Progression of long wave features in the vicinity of North America was associated with marked temperature changes in some parts of the United States. The strong mean ridge over the Rockies brought above normal temperatures to most areas west of the Continental Divide (fig. 4), replacing low temperatures in southern portions during June [1].

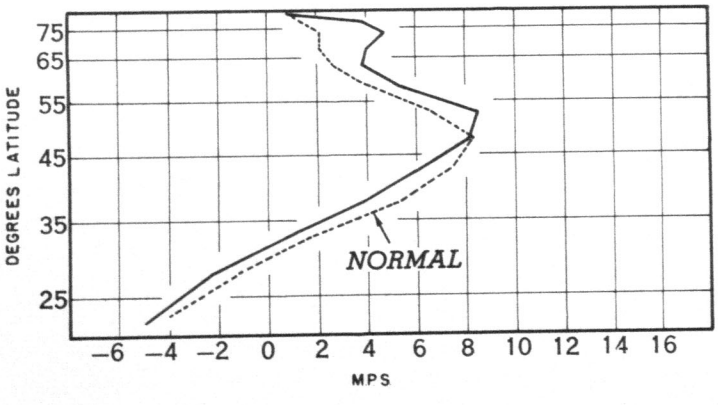


FIGURE 1.—Monthly mean zonal wind speed profile (meters per second) at 700 mb. for the western portion of the Northern Hemisphere for July 1967, and July normal (dashed).

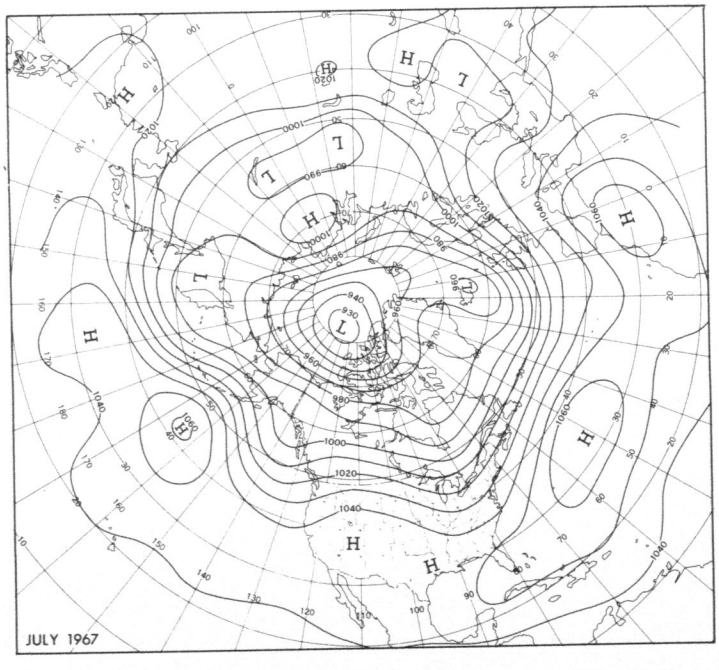


FIGURE 2.—Mean 700-mb. contours (tens of feet), July 1967.

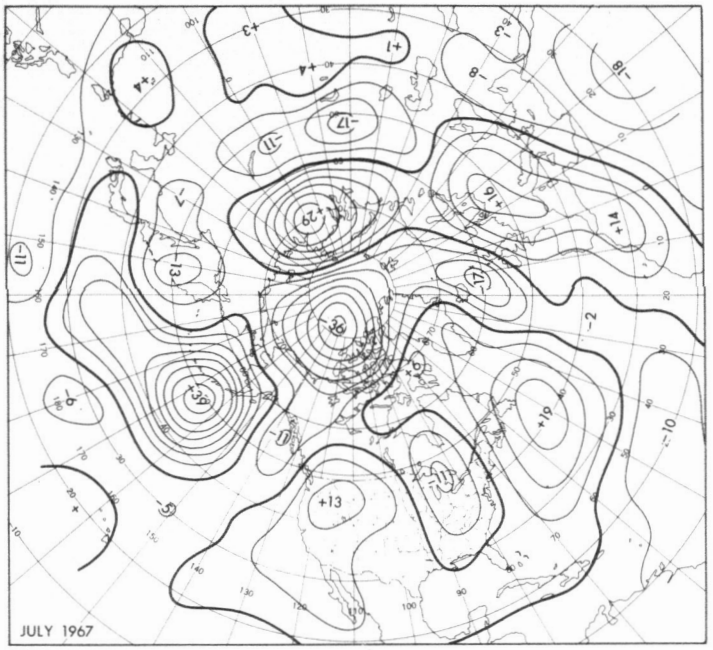


FIGURE 3.—Departure from normal of mean 700-mb. heights from normal (tens of feet), July 1967.

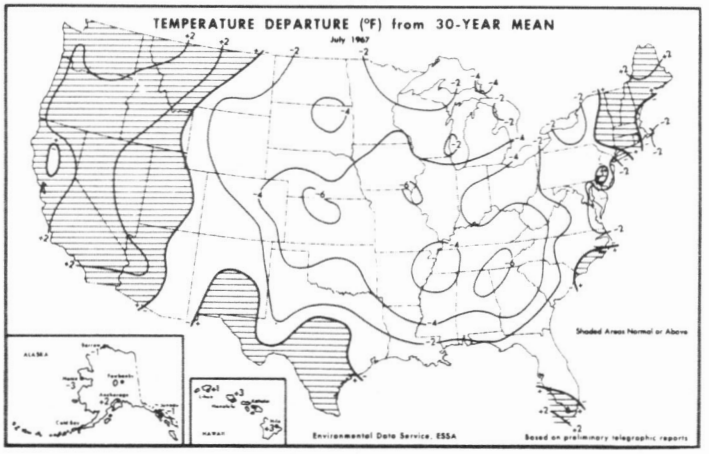


FIGURE 4.—Surface temperature departure from normal (°F.), July 1967 (from [2]).

Below normal temperatures prevailed east of the Divide, except for near to above normal in the extreme Southern Plains and along the Atlantic coast. This was largely an area of stronger than normal northerly wind components aloft between the western ridge and the eastern trough. This flow was indicative of the frequent cold air outbreaks into the eastern United States which contributed to record or near record July mean temperatures at many locations. Cities observing new July lows included Waterloo, Iowa; Fort Wayne, Ind.; Bristol and Chattanooga, Tenn.; Macon, Ga.; and Montgomery, Ala. The fringe of above normal temperatures

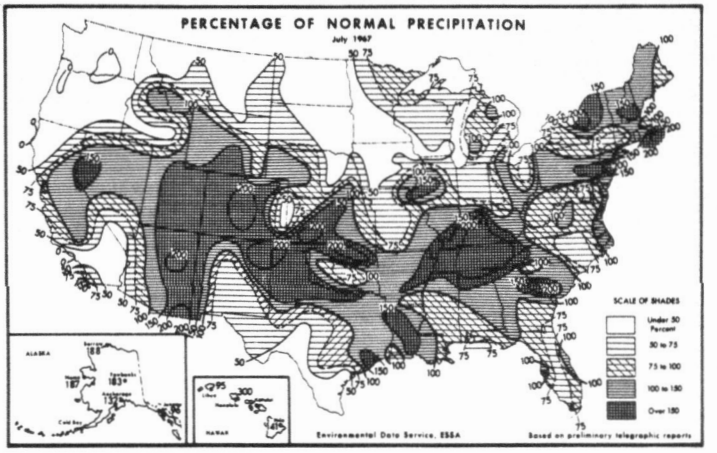


FIGURE 5.—Percentage of normal precipitation, July 1967 (from [2]).

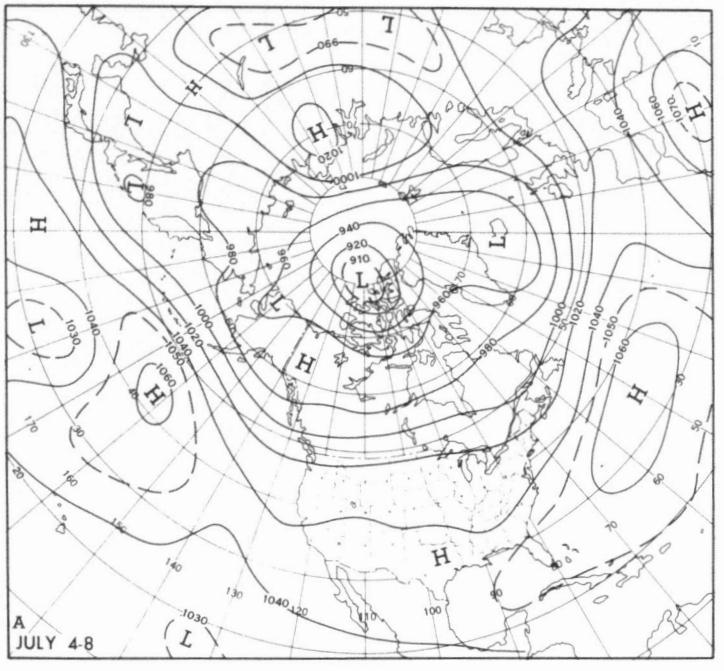
along the east coast with cooler temperatures to the west reveals the existence of a mean frontal zone between cold air masses from the northwest and warmer air streaming northward along the seaboard between the amplified Bermuda High and Great Lakes trough.

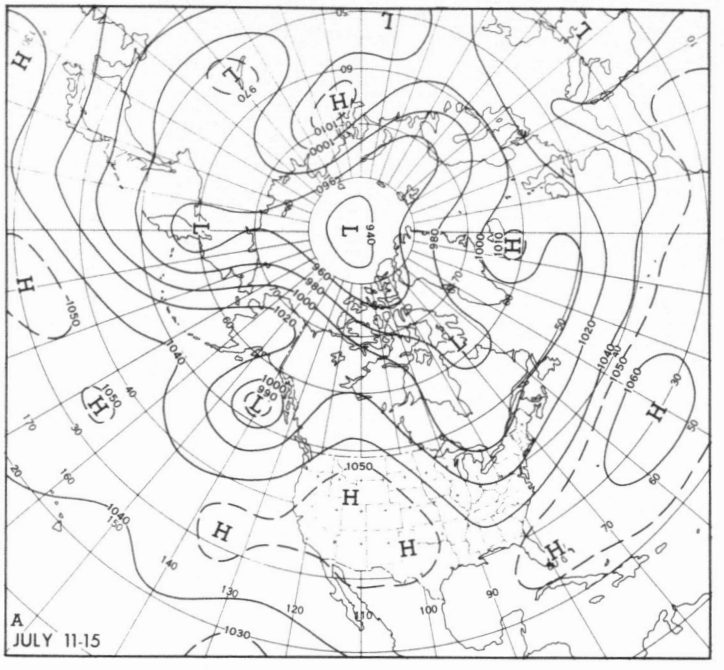
3. PRECIPITATION

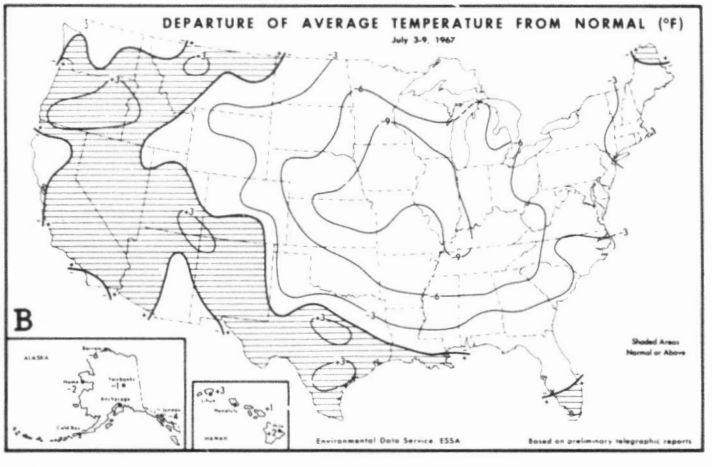
With the building of a strong western ridge, precipitation over most of the West Coast States was subnormal during July (fig. 5). By the end of July both Portland and Eugene, Oreg., had observed 39 consecutive days without measurable precipitation. Sufficient moisture was advected into the West to the south of the double-centered mean western High (fig. 2) to yield above normal precipitation over parts of the Central and Southern Plateau, central Rockies, and central California.

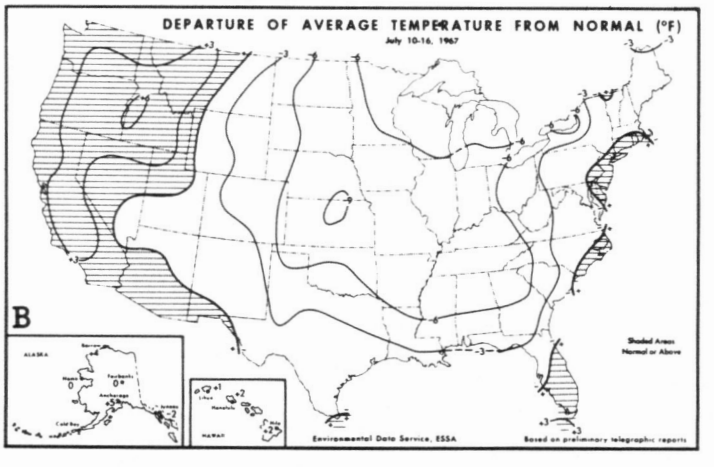
East of the Divide frequent cold front passages contributed to the large area of above normal precipitation from the central Rockies through the middle Mississippi Valley to the East. Over the Northern Plains and the northern Mississippi Valley, lack of moisture due to stronger than normal northerly upper flow components (fig. 3) resulted in one of the driest Julys at numerous stations and the driest July of record at Havre, Mont. (0.01 in.), and at La Crosse, Wis. (0.16 in.).

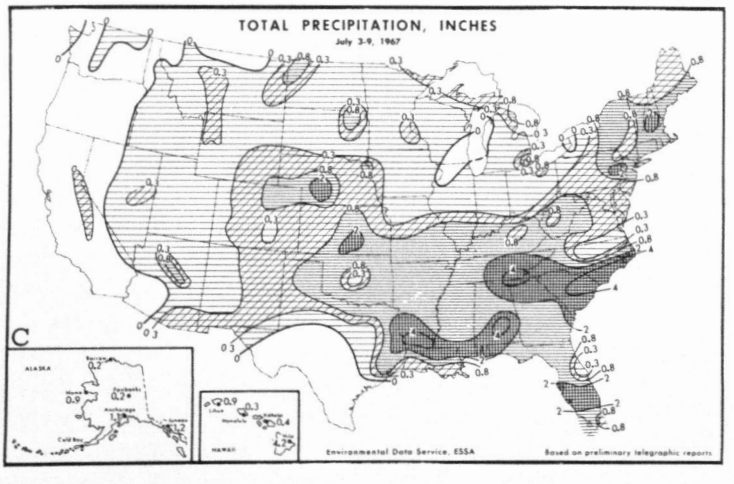
Relatively heavy precipitation along the eastern seaboard was associated with the mean frontal zone in that area which drew upon a bountiful moisture supply advected to coastal regions by the stronger than normal southerly flow (fig. 3). This flow also produced frequent fogs along the Northeast coast as the warm, moist air was cooled in passage over cool coastal waters. At Nantucket, Mass., there were 29 days with fog, 27 of which were classified as heavy. Other foggy locations were Providence, R.I., and Portland, Maine, both of which observed 27 days with fog. This was the first July since 1961 with widespread above normal precipitation in the Northeast. As pointed out by Namias [3], the recent











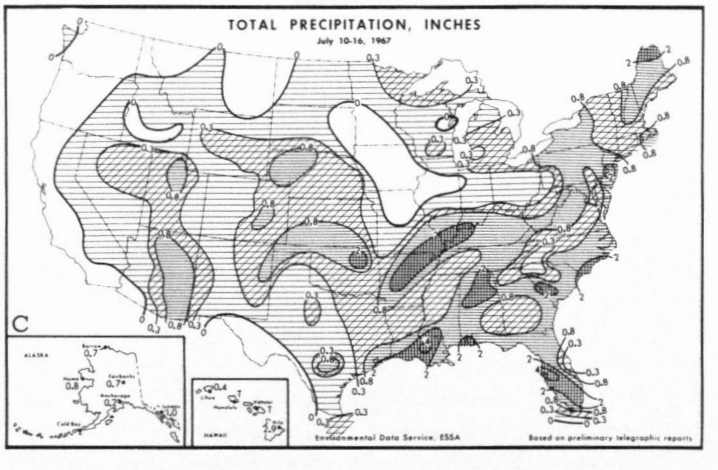
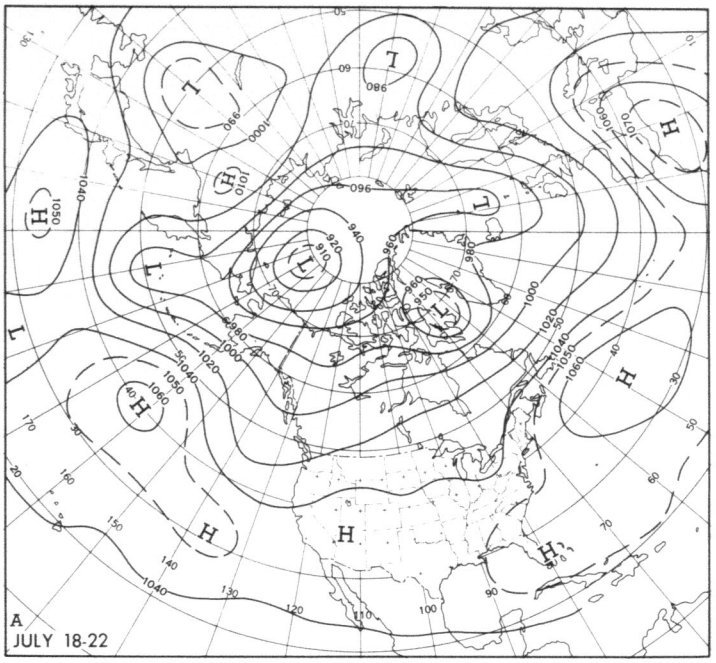
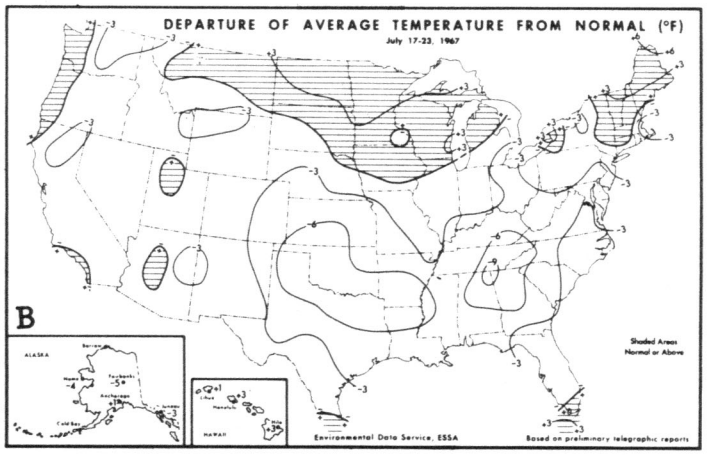


FIGURE 6.—Week of July 3–9, 1967: (A) 700-mb. contours (tens of feet), July 4–8; (B) Surface temperature departure from normal (°F.); (C) Total precipitation (in.); (B) and (C) from [3].

FIGURE 7.—Week of July 10–16, 1967; (A) 700-mb. contours (tens of feet), July 11–15; (B) and (C) same as figure 6.





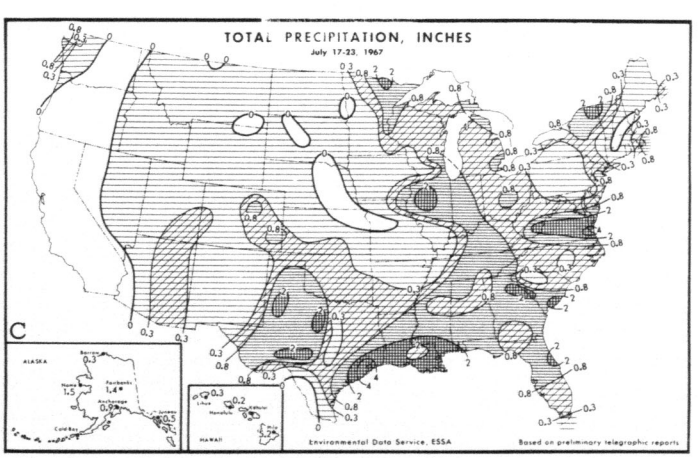
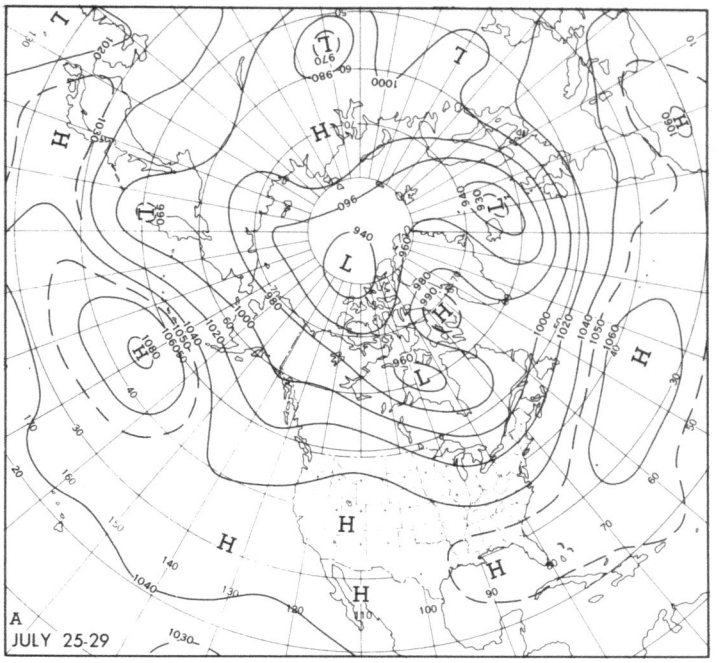
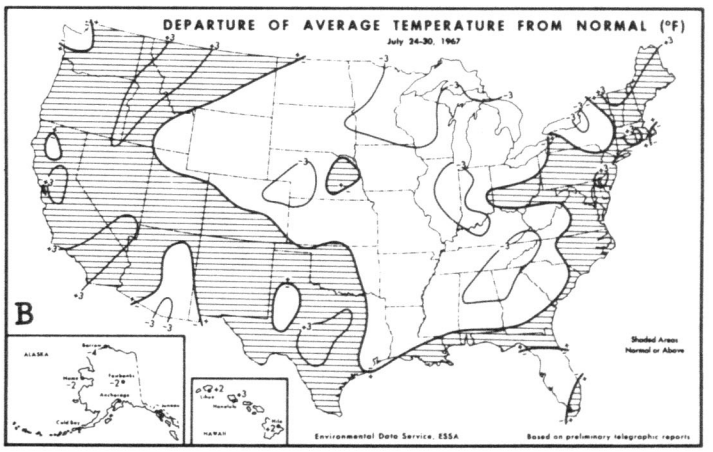


FIGURE 8.—Week of July 17–23, 1967; (A) 700-mb. contours (tens of feet), July 18–22; (B) and (C) same as figure 6.





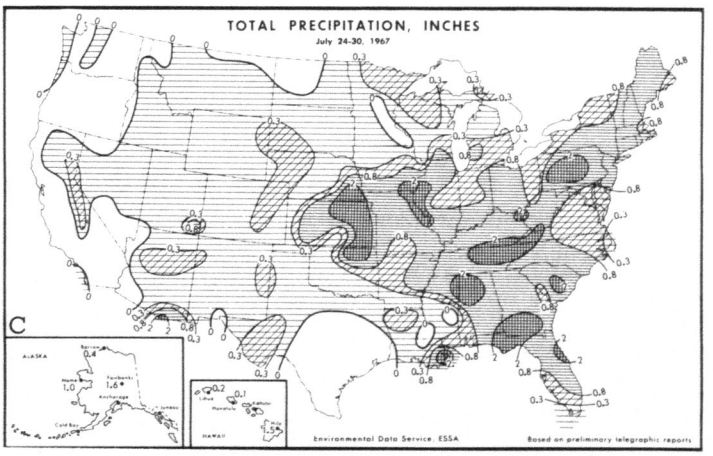


FIGURE 9.—Week of July 24–30, 1967; (A) 700-mb. contours (tens of feet), July 25–29; (B) and (C) same as figure 6.

drought in the Northeast has been mainly a summer phenomenon making this July's rainfall especially significant.

4. VARIABILITY WITHIN THE MONTH

Weekly distributions of temperature and precipitation accompanied by appropriate 5-day mean 700-mb. maps are shown in figures 6 through 9 (pp. 702–703). This series of maps presents a good example of the successive amplification of downstream waves. Beginning with the injection of cyclonic vorticity into the Asiatic coastal trough east of the retrograding Asiatic block (fig. 6), amplification can be followed through the Pacific ridge, the east Pacific trough, the western North American ridge and the eastern North American trough (fig. 7) to the western Atlantic ridge, the eastern Atlantic trough, and the North African-European ridge (fig. 8).

During the course of the month there were only small variations in mean trough and ridge locations near the United States (figs. 6A–9A). Such variations of temperature and precipitation as occurred were related mainly to changes in the strength of these features during the month.

Despite amplification of the flow pattern with time during the first half month there was little variation in the temperature distribution in the United States (figs. 6 and 7). The cold air in mid-Nation during July 3–9 began its southward push from higher latitudes during the preceding week when a more amplified wave pattern existed. This air mass brought record low July temperatures to Omaha, Nebr. (47°F.), on July 3 and Duluth, Minn. (36°F.), on July 5.

Highest weekly mean temperatures in the west and some of the lowest daily temperatures east of the Divide occurred during the July 10–16 period when the flow pattern was most amplified. Toward the end of this period, record low July temperatures were observed from Detroit, Mich., and Fort Wayne, Ind., southward to the Gulf coast, as shown in table 1. As the flow pattern flattened, highest temperatures of the month spread across the North-central States, isolating the residual cold air to the south (fig. 8).

Along the eastern seaboard, weekly fluctuations from below to above normal temperatures, together with plentiful precipitation, evidence the proximity of a mean frontal boundary during the month (figs. 6–9). Elsewhere east of the Divide the overall precipitation pattern also persisted during the course of the month (figs. 6–9), and was primarily of a frontal origin. The inception of precipitation in Texas can be seen to accompany the spreading of cold air into that region (figs. 7 and 8).

The western moist tongue was evident throughout the month, producing the greatest amount of precipitation during the second week (fig. 7C) when the ridge over the Southern Plains was strongest and there was maximum advection of Gulf air into the Plateau region.

TABLE 1.—*Record July minimum temperatures, 1967*

Location	Temperature (°F.)	Date
Fort Wayne, Ind.	44	July 14.
Detroit, Mich.	46	July 14.
Cincinnati, Ohio	52	July 14.
St. Louis, Mo.	*51	July 14.
Springfield, Mo.	49	July 14.
Chattanooga, Tenn.	51	July 15.
Birmingham, Ala.	51	July 15.
Columbus, Ga.	*59	July 15.
Macon, Ga.	54	July 15.
Alexandria, La.	55	July 15.
Port Arthur, Tex.	61	July 15.
Pensacola, Fla.	61	July 15, 16.

*Tied record.

5. TROPICAL STORM ACTIVITY

The amplified wave pattern and stronger than normal subtropical easterlies over the Pacific were associated with tropical storm activity throughout the month in the western Pacific. The four typhoons of the month (Billie, Clara, Dot, and Ellen) all formed 20–30° longitude east of the Philippines. Two of these storms struck the China coast while two recurved. One of the latter, after becoming an extratropical wave, brought torrential rains to southern Japan on July 8–9. News reports indicated 289 dead and 452 injured from flooding and landslides at Hiroshima and Nagasaki.

This was also an active month in the east Pacific where four tropical storms were observed. Three of these storms traveled westward while one drifted northward to the vicinity of Baja California bringing small amounts of precipitation to extreme southern California.

No tropical storms were observed in the Atlantic this month despite the amplified ridge (figs. 1 and 2) which brought stronger than normal easterlies south of the subtropical ridge.

REFERENCES

1. A. J. Wagner, "The Weather and Circulation of June 1967—A Cool Month With Excessive Rainfall in the Plains," *Monthly Weather Review*, vol. 95, No. 9, Sept. 1967, pp. 650–656.
2. Environmental Data Service, ESSA, *Weekly Weather and Crop Bulletin*, vol. 54, Nos. 28–32, July 10, 17, 24, 31, and Aug. 7, 1967, pp. 1–8.
3. J. Namias, "Nature and Possible Causes of the Northeastern United States Drought During 1962–65," *Monthly Weather Review*, vol. 94, No. 9, Sept. 1966, pp. 543–554.

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